Length-Weight Relations for Adult Sockeye, Chum, and Pink Salmon

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November 1985

Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1846

86-1148/

Canadian Manuscript Report of Fisheries and Aquatic Sciences

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LENGTH-WEIGHT RELATIONS FOR ADULT SOCKEYE, CHUM, AND PINK SALMON

by

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Cat. No. Fs 97-4/1846E ISSN 0705-6473

Correct citation for this publication:

Bilton, H. T. 1985. Length-weight relations for adult sockeye, chum, and pink salmon. Can. MS Rep. Fish. Aquat. Sci. 1846: 8 p.

ABSTRACT

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Length and weight data for 7622 sockeye, 4296 pink and 2806 chum salmon sampled from commercial net fisheries along the British Columbia coast in 1965 and 1966 were used in the study. Regression formulae were calculated by species, year, statistical catch area, age and sex. Results of analysis indicate highly significant correlations for each species between length and weight.

RESUME

Bilton, H. T. 1985. Length-weight relations for adult sockeye, chum, and pink salmon. Can. MS Rep. Fish. Aquat. Sci. 1846: 8 p.

Cette étude a utilisé les données sur la longueur et le poids de 7622 saumons sockeye, 4296 saumons roses et 2806 saumons kéta provenant de la pêche commerciale au filet le long de la côte de la Colombie-Britannique en 1965 et 1966. Des formules de régression ont été calculées par espèce, par année, par zone statistique de prise, par âge et par sexe. Les résultats de l'analyse indiquent qu'il existe des corrélations très significatives entre la longueur et le poids pour chaque espèce.

INTRODUCTION

For many years information on the age, size and sex composition of sockeye (Oncorhynchus nerka), pink (O. gorbuscha) and chum (O. keta) salmon was obtained from samples of the catches of all substantial B.C. fisheries (e.g. Bilton et al. 1967).

The sampling process included determination of sex and measurement of length. A selection of scales for later examination to determine age and subsamples of weights was taken. Information on age, sex and length composition was published annually. However, weights of individual fish were not included, although the data were available.

The present report describes the length-weight relations by major catch area, age, and sex, using data collected in 1965 and 1966.

METHODS AND MATERIALS

Annually the catches of the three species were sampled on a routine basis. A set number of samples were taken from the catch in each major fishing area, each week. Lengths were taken in centimeters from the posterior orbit of the eye to the end of the hypural plate (the last vertebra in the spinal column). Each fish was also sampled for sex and scales. Individuals in a sub-sample were weighed. Weights were taken in kilograms to a precision of 1/100 kg. Data for 7622 sockeye, 4294 pink and 2806 chum salmon sampled from commercial net fisheries along the British Columbia coast in 1965 and 1966 were used in this study.

Correlation coefficients and lines of best fit describing the relationship of fish length with weight were calculated for each species by catch area, by year, by age[1], and by sex. Prior to calculation of the regression lines length and weight data were transformed to log base 10 values. Hence, the following formula is used to estimate weight from length:

$$\log \text{weight} = \log a + b\ (\log \text{length})$$

Transformation of the resulting log values for weights back to kilograms provide estimated weights to a precision of 1/100 kg. Functional

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[1]The European system of age designation (Koo 1962) is used in this report. The first digit indicates the number of annuli formed in fresh water and the second digit indicates the number of annuli formed while the fish was in the ocean.

regression parameters were also calculated (Ricker 1973). The functional slope (v) was calculated by division of the slope (b) for y on x by the correlation coefficient (r). The functional intercept ($\underline{u}$) was calculated using the log values for x (length) and y (weight) and the functional slope ($\underline{v}$).

RESULTS AND DISCUSSION

The correlation coefficients, slopes and intercepts of regression lines describing the relations between fish length and their body weight, by species, catch area, year, age and sex are given in Table 1.

For sockeye salmon where sample sizes consisted of 30 or more fish, the correlation coefficients exceeded 0.9 in 18 out of 45 comparisons. In 14 other cases the r values ranged between 0.8 and 0.9 with the remaining 13 ranging between 0.36 and 0.79. The reason for the very low correlation coefficient (0.36 to 0.52) observed in 3 comparisons (Skeena R., 1965, age 1.2 and 1.3 females and Fraser R., 1965, age 1.2 females) where sample sizes were 182, 231, and 457 fish respectively are not known. All correlations were statistically significant ($P<.05$). The slopes ($\underline{v}$) varied considerably among groups. For samples of 30 or more and r-values of 0.7 or more, the functional slopes (v) ranged from 2.778 to 4.193.

Overall average values for $\underline{u}$ and $\underline{v}$ were calculated for males and females separately and combined, excluding the same groups as mentioned above. The regression formulae are as follows:

Males	log weight = -5.106 + 3.275 (log length)
Females	log weight = -5.217 + 3.330 (log length)
Males and females	log weight = -5.160 + 3.302 (log length)

Estimated weights derived from the formula for sockeye of different lengths are given in the following table:

Length (cm)	Weight (kg)		
	Male	Female	Male and female
40	1.38	1.31	1.35
45	2.03	1.94	1.99
50	2.87	2.76	2.82
55	3.92	3.78	3.85
60	5.21	5.06	5.14

For chum salmon where sample sizes consisted of 30 or more fish, the correlation coefficients exceeded 0.9 in 4 out of 13 comparisons. In 8 of the cases, the r values ranged between 0.8 and 0.9, while the remaining sample had a low value of 0.45 (Bella Coola age 0.4 males 1965). All correlations were statistically significant ($P<.05$).

The slopes (v) varied among groups. For samples of 30 or more and r-values of 0.7 or more, the functional slopes (v) ranged from 3.361 to 3.896. Overall average values of $\bar{u}$ and $\bar{v}$ were calculated for males and females separately, and combined, excluding the same groups as mentioned above. The regression formulae are as follows:

Males	log weight = -5.787 + 3.669 (log length)
Females	log weight = -5.448 + 3.458 (log length)
Males and females	log weight = -5.617 + 3.563 (log length)

Estimated weights derived from the formulae for chums of different lengths are given in the following table:

Length	Weight (kg)		
(cm)	Male	Female	Male and female
40	1.23	1.23	1.23
45	1.90	1.85	1.88
50	2.80	2.67	2.74
55	3.95	3.71	3.83
60	5.44	5.01	5.22
65	7.33	6.62	6.97
70	9.59	8.55	9.06

For pink salmon all 14 groups consisted of sample sizes of more than 30 fish (35 to 970 fish). Of the 14 groups the correlation coefficients exceeded 0.9 in 9 comparisons. In 3 other cases r values ranged between 0.8 and 0.9 and the remaining single case had the lowest value of 0.738. All correlations were statistically significant ($P<.05$).

The slopes (v) varied considerably among groups common here ranging from 2.648 to 3.653. Overall average values for $\bar{u}$ and $\bar{v}$ were calculated for males and females separately and combined. The regression formulae are as follows:

Males	log weight = -5.274 + 3.396 (log length)
Females	log weight = -5.151 + 3.312 (log length)
Males and females	log weight = -5.213 + 3.354 (log length)

Estimated weights derived from the formulae for pinks of different lengths are given in the following table:

Length (cm)	Weight (kg)		
	Male	Female	Male and female
40	1.47	1.43	1.45
45	2.19	2.11	2.14
50	3.13	2.99	3.06
55	4.32	4.09	4.20

Finally, comparison of the length-weight relationship between males and females of the same species indicates that for fish of the same length, males were heavier than females. Also comparison among the three species for fish of the same length indicates pinks generally weighed the most and chums the least.

ACKNOWLEDGMENTS

The author would like to thank Dr. W. E. Ricker for his helpful criticisms of the manuscript and Dr. Randall M. Peterman who encouraged him to publish this information.

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Table 1. The hypural length-weight relations for sockeye, chum and pink salmon sampled from fishery catches in various statistical areas in 1965 and 1966. Data are given by year, age-class and sex. Table shows regression formula derived after lengths (cm) and weights (kg) were transformed to log base 10 values.

Species	Statistical area	Year	Age class	Sex	N	a	b	r	Length $\bar{x}$	Weight $\bar{y}$	Functional regression parameters u	v
Sockeye	Nass River	1965	1.2	F	221	-3.500	2.295	0.826*[a]	1.679	0.355	-4.310	2.778
	(03)		1.3	F	85	-2.682	1.827	0.676*	1.701	0.425	-4.172	2.703
			1.2	M	216	-3.903	2.550	0.868*	1.687	0.400	-4.556	2.938
			1.3	M	56	-3.505	2.323	0.834*	1.722	0.494	-4.302	2.785
	"	1966	1.2	F	146	-4.754	3.063	0.925*	1.667	0.351	-5.169	3.311
			1.3	F	174	-3.291	2.212	0.768*	1.714	0.500	-4.437	2.880
			1.2	M	138	-4.954	3.198	0.952*	1.673	0.398	-5.222	3.359
			1.3	M	104	-4.010	2.641	0.894*	1.732	0.562	-4.554	2.954
"	Skeena River	1965	1.2	F	182	-2.458	1.670	0.520*	1.677	0.342	-5.043	3.212
			1.3	F	231	-3.654	2.393	0.510*	1.702	0.420	-7.566	4.692
	(04)		1.2	M	193	-3.193	2.129	0.756*	1.684	0.392	-4.350	2.816
			1.3	M	98	-4.545	2.930	0.645*	1.716	0.485	-7.310	4.543
	"	1966	1.2	F	69	-4.261	2.767	0.824*	1.662	0.338	-5.243	3.358
			1.3	F	71	-3.851	2.535	0.635*	1.711	0.487	-6.314	3.992
			1.2	M	69	-4.966	3.197	0.931*	1.670	0.373	-5.362	3.434
			1.3	M	42	-4.607	2.991	0.910*	1.730	0.566	-5.120	3.287
"	Bella Coola	1965	1.2	F	228	-5.094	3.241	0.932*	1.634	0.203	-5.479	3.477
			1.3	F	37	-5.438	3.448	0.945*	1.672	0.329	-5.772	3.649
	(08)		1.2	M	109	-4.915	3.147	0.967*	1.632	0.222	-5.089	3.254
			1.3	M	4	-7.059	4.424	0.992*	1.709	0.500	-7.122	4.460
	"	1966	1.2	F	259	-4.690	3.010	0.914*	1.656	0.296	-5.158	3.293
			1.3	F	105	-5.255	3.358	0.871*	1.700	0.452	-6.102	3.855
			1.2	M	199	-4.616	2.986	0.915*	1.668	0.366	-5.077	3.263
			1.3	M	53	-2.575	1.816	0.527*	1.715	0.540	-5.370	3.446

Table 1 (cont'd)

Species	Statistical area	Year	Age class	Sex	N	a	b	r	Length - x	Weight - y	Functional regression parameters u	v
Sockeye	Rivers Inlet	1965	1.2	F	145	-4.002	2.559	0.902*	1.660	0.311	-4.472	2.881
			1.3	F	57	-4.914	3.155	0.944*	1.696	0.436	-5.232	3.312
	(09)		1.2	M	173	-4.200	2.730	0.956*	1.651	0.308	-4.407	2.856
			1.3	M	30	-5.496	3.508	0.977*	1.698	0.462	-5.635	3.591
		1966	1.2	F	185	-4.323	2.806	0.840*	1.655	0.321	-5.207	3.340
			1.3	F	437	-3.715	2.471	0.746*	1.713	0.517	-5.157	3.312
			1.2	M	214	-4.253	2.776	0.872*	1.647	0.321	-4.922	3.183
			1.3	M	227	-4.152	2.743	0.806*	1.724	0.576	-5.291	3.403
"	Smith Inlet	1965	1.2	F	185	-4.265	2.765	0.885*	1.656	0.313	-4.861	3.123
	(10)		1.3	F	164	-5.078	3.255	0.924*	1.698	0.447	-5.535	3.523
			1.2	M	341	-4.500	2.922	0.936*	1.650	0.320	-4.831	3.122
			1.3	M	93	-4.911	3.169	0.856*	1.704	0.488	-5.820	3.702
		1966	1.2	F	3	-2.738	1.855	0.946*	1.672	0.364	-2.915	1.961
			1.3	F	94	-4.321	2.826	0.800*	1.717	0.533	-5.532	3.533
			1.2	M	7	-5.421	3.491	0.984*	1.681	0.449	-5.515	3.548
			1.3	M	69	-2.762	1.948	0.633*	1.723	0.593	-4.709	3.077
"	Fraser River	1965	1.2	F	457	-1.180	0.928	0.356*	1.687	0.385	-4.013	2.607
	(29)		1.3	F	49	-5.072	3.230	0.900*	1.717	0.474	-5.688	3.589
			1.2	M	374	-4.732	3.044	0.918*	1.692	0.420	-5.191	3.316
			1.3	M	39	-5.104	3.261	0.956*	1.724	0.519	-5.362	3.411
		1966	1.2	F	591	-3.336	2.218	0.710*	1.699	0.432	-4.876	3.124
			1.3	F	35	-4.874	3.140	0.870*	1.725	0.542	-5.684	3.609
			1.2	M	526	-4.031	2.644	0.789*	1.703	0.472	-5.235	3.351
			1.3	M	38	-5.751	3.648	0.870*	1.736	0.584	-6.695	4.193

Table 1 (cont'd)

Species	Statistical area	Year	Age class	Sex	N	a	b	r	Length $\bar{x}$	Weight $\bar{y}$	Functional regression parameters u	v
Chum	Nass River (03)	1965	0.2	F	5	-4.134	2.684	0.990*	1.734	0.519	-4.182	2.711
			0.3	F	95	-4.288	2.778	0.826*	1.766	0.618	-5.321	3.363
			0.4	F	24	-5.540	3.484	0.943*	1.787	0.686	-5.016	3.695
			0.2	M	6	-4.142	2.701	0.905*	1.701	0.451	-4.626	2.985
			0.3	M	127	-5.265	3.555	0.953*	1.785	0.720	-5.939	3.730
			0.4	M	27	-5.796	3.646	0.962*	1.813	0.815	-6.056	3.790
"	Skeena River (04)	1965	0.3	F	5	-3.409	2.294	0.849	1.748	0.600	-4.123	2.702
			0.3	M	3	-7.612	4.683	0.977*	1.739	0.530	-7.805	4.793
"	Bella Coola (08)	1965	0.2	F	36	-5.503	3.490	0.972*	1.744	0.584	-5.678	3.591
			0.3	F	91	-4.805	3.089	0.886*	1.773	0.672	-5.509	3.486
			0.4	F	37	-4.731	3.051	0.858*	1.805	0.795	-5.643	3.556
			0.2	M	44	-5.876	3.725	0.959*	1.759	0.678	-5.606	3.572
			0.3	M	148	-5.500	3.506	0.900*	1.805	0.827	-6.204	3.896
			0.4	M	36	-3.409	2.337	0.450*	1.822	0.848	-8.614	5.193
		1966	0.2	F	176	-3.912	2.606	0.817*	1.759	0.672	-4.939	3.190
			0.3	F	791	-4.730	3.071	0.863*	1.775	0.719	-5.597	3.559
			0.4	F	17	-5.652	3.584	0.818*	1.786	0.749	-7.076	4.381
			0.2	M	171	-5.634	3.603	0.955*	1.758	0.701	-5.932	3.773
			0.3	M	822	-4.939	3.208	0.872*	1.791	0.808	-5.781	3.679
			0.4	M	17	-5.289	3.398	0.904*	1.811	0.864	-5.943	3.759
"	Fraser River (29)	1965	0.3	F	24	-4.640	2.989	0.880*	1.762	0.628	-5.358	3.392
			0.2	M	1	-	-	-	-	-	-	-
			0.3	M	53	-4.317	2.830	0.842*	1.775	0.706	-5.260	3.361
			0.4	M	4	-4.862	3.126	0.986*	1.783	0.712	-4.941	3.170
		1966	0.2	F	1	-	-	-	-	-	-	-
			0.3	F	23	-3.354	2.287	0.804*	1.776	0.708	-4.344	2.845
			0.2	M	1	-	-	-	-	-	-	-
			0.3	M	21	-4.158	2.773	0.824*	1.782	0.784	-5.213	3.365

Table 1 (cont'd)

Species	Statistical area	Year	Age class	Sex	N	a	b	r	Length $\bar{x}$	Weight $\bar{y}$	Functional regression parameters u	v
Pink	Nass River (03)	1965	0.1	F	262	-4.700	3.027	0.837*	1.651	0.296	-5.675	3.616
			0.1	M	346	-4.835	3.210	0.957*	1.653	0.323	-5.066	3.260
"		1966	0.1	F	148	-4.850	3.141	0.972*	1.623	0.263	-5.144	3.331
			0.1	M	152	-4.992	3.238	0.972*	1.623	0.263	-5.144	3.331
	Skeena River (04)	1965	0.1	F	35	-2.929	1.954	0.738*	1.651	0.298	-4.073	2.648
			0.1	M	50	-4.731	3.048	0.948*	1.652	0.303	-5.008	3.215
		1966	0.1	F	224	-3.732	2.454	0.791*	1.636	0.282	-4.794	3.102
			0.1	M	174	-4.768	3.096	0.927*	1.645	0.325	-5.168	3.340
"	Bella Coola (08)	1965	0.1	F	388	-5.129	3.290	0.922*	1.652	0.308	-5.587	3.568
			0.1	M	372	-5.368	3.446	0.977*	1.655	0.335	-5.502	3.527
		1966	0.1	F	874	-4.828	3.123	0.878*	1.635	0.277	-5.539	3.557
			0.1	M	970	-5.035	3.262	0.946*	1.651	0.352	-5.341	3.448
"	Fraser River (29)	1965	0.1	F	119	-4.615	2.991	0.889*	1.689	0.436	-5.246	3.364
			0.1	M	180	-5.209	3.368	0.922*	1.697	0.508	-5.691	3.653

[a]Indicates significant at the 0.05 probability level.